BREATHABLE ARTICLES AND FABRICS

FIELD OF THE INVENTION

The present invention relates to breathable articles, and more particularly articles that in use are disposed between a part of a body of a person or animal and a surface (which may optionally be perforated). Such articles may, for example, include apparel of all types (e.g. watersports apparel), parts of wheelchairs, seats of all types (e.g. automotive seating, office seating, domestic seating, boat seating, commercial travel seating such as bus, train and aircraft seating), headwear of all types, shoe insoles, helmet linings, linings for body protection or body armour, lining for sports shields such as shin-pads, under-blankets for bedding, upholstery covers, linings for clothing, medical dressings, orthopaedic cast linings or linings for orthopaedic supports or hard braces. The articles may also include medical and veterinary dressings, which may for example be held onto the body by an overlying cover member or by winding the dressing onto itself around the part of the body. The word "article" used herein includes portions of articles. The invention also relates to breathable fabrics from which such articles (and others) can be manufactured.

DESCRIPTION OF THE PRIOR ART

International (PCT) Patent Application No. WO-A 91/12958 (Armstrong and Middleton) (the disclosure of which is incorporated herein by reference) discloses a breathable insulating fabric in which perforations are provided, the fabric being so configured in the region of each perforation that on one side of the fabric a dome projection extends and on the other side a hollow depression chamber is provided in the fabric (Fig. 2a). In an alternative construction, the dome may be omitted (Fig. 1). The dome version is marketed by Micro Thermal Systems Limited of Bodmin, UK (tel: +44 1208 79999; fax: +44 1208 79990), under the trade mark STOMATEX.

BACKGROUND OF THE INVENTION

A disadvantage of known breathable fabrics lies in the fact that the breathing action can be inhibited if an article made from the fabric is disposed between a part of a body of a person or animal and a surface. The disadvantage is particularly serious if the surface is hard and/or unperforated and/or if there is a positive external pressure on the article, for example from the weight of the person or animal or from the surface being held tightly against the article.

It is an object of the present invention to go at least some way towards overcoming the above disadvantage, or at least to provide an alternative to the existing products.

SUMMARY OF THE INVENTION

According to a first aspect of the present invention, therefore, there is provided an article comprising a sheet having first and second major faces directed respectively to first and second sides of the article and adapted to be disposed at least intermittently in use between, to the first side, a part of a person or animal and, to the second side, a surface, the sheet being formed of a substantially impermeable material having perforations provided therethrough, characterised in that there is further provided a plurality of spacer members which project from at least one of the said major faces of the sheet between perforations of the sheet for spacing the sheet from the said part of the person or animal, from the said surface, or from both of these, whereby in use between both the surface and the part of a person or animal the article is breathable to restrict discomfort to the person or animal.

According to a second aspect of the present invention, there is provided a breathable fabric, for use particularly, but not exclusively, in manufacturing an article according to the first aspect of the present invention, the fabric comprising a sheet having first and second major faces and formed of a substantially impermeable material having perforations provided

therethrough, characterised in that there is further provided a plurality of spacer members which project from at least one of the major faces of the sheet between perforations of the sheet for spacing the sheet in use from a part of a person or animal, from a surface, or from both of these on opposite major faces of the sheet.

In a particular embodiment, the spacer members project from at least the second major face of the sheet (optionally from only the second major face of the sheet) for spacing the sheet from the said surface.

In a further embodiment, the spacer members may project from at least the first major face of the sheet (optionally from only the first major face of the sheet) for spacing the sheet from the person or animal.

In a preferred form of the invention, the sheet further includes a hollow depression or chamber provided in the first major face of the sheet in the region of each perforation. In the way described in WO-A 91/12958, such an arrangement permits air passing from the first to the second side of the article to accumulate in the depression or chamber under increased vapour pressure prior to passing out to the second side of the article.

Furthermore, one depression or chamber may be associated with more than one perforation. The cross-dimension of the depression or chamber may, for example, be in the range of about 0.4 mm to about 50 mm, more typically about 0.4 mm to about 30 mm. The surface density of depressions or chambers on the sheet may be up to about 500,000 m^{-2}, for example between about 200 and about 500,000 m^{-2}. The size and surface density of depressions or chambers can be chosen by one or ordinary skill in the art, according to the breathability properties required. For example, a surface density of over 100,000 small depressions or chambers per m^2, with associated perforations typically having a cross-dimension of less than about 0.1 mm, e.g. possibly as low as about 0.01 mm, may be useful for specialised articles such as medical or veterinary dressings or other coverings.

The thickness of the sheet may be chosen to suit the desired application of the article. For example, the thickness may be from 0.5-100 mm, e.g. less than about 50 mm, particularly from 1-30 mm, most particularly from about 3 to about 15 mm.

The perforations may be of any convenient or advantageous shape, e.g. circular, slit-like or elliptical, when viewed along their lengths, and suitably have a cross-dimension up to about 5 mm (e.g. from about 0.01 mm to about 5 mm). The perforations are suitably about the size of a pin-prick, e.g. about 0.2 to about 2 mm in diameter. The centres of adjacent perforations may suitably be up to about 100 mm, e.g. up to approximately 30 mm, apart and the perforations may be arranged in a repeating diamond pattern across the sheet.

The expression "fabric" used herein includes a fabric portion, and the expression "sheet" includes a sheet portion.

The spacer members may, for example, project from the sheet by a distance which is substantially constant across at least the majority of the relevant major face of the sheet, so that the article conforms in use to the shape of the person or animal or the surface. Alternatively, the spacer members may be of variable length in the direction away from the sheet, for example to accommodate specific contours of the surface or the person or animal's body. The spacer members may be discontinuous or continuous. They may suitably comprise ribs or discrete or point projections extending from the sheet. The spacer members may, for example, be attached to the sheet or may be integral with the sheet.

The substantially impermeable sheet may be a unitary sheet or a laminate, and is preferably elastomeric. The component(s) may be foamed or unfoamed. If foamed, the foam structure can be closed-cell or open-cell. While an open-cell foam will normally have some inherent permeability, such a foam is still understood to be "substantially impermeable" in the context of the present invention if the presence of perforations makes a recognisable improvement to breathability. Suitable elastomeric materials include synthetic

and natural rubbers, for example neoprene rubber, and/or synthetic polymers of all types. In the case of a laminate, different materials may if desired be used for different lamina.

The sheet is preferably a sheet of the general STOMATEX type described above. Most preferably, the second major face of the sheet is provided with dome projections in the region of each perforation, corresponding with the hollow chambers of the first major face of the sheet. In use, the domes flex as the pressure changes take place in the chamber, and this flexing assists in the removal of moist air away from the person's skin adjacent the first major face of the sheet.

In this preferred embodiment, the spacer members are adapted to maintain the domes spaced from the surface and thereby to prevent inhibition of the flexing action during normal use.

The spacer members preferably project from the second major face of the sheet by an amount which is substantially the same across at least the majority of the second major face of the sheet, so that the article conforms in use to the shape of the surface. The spacer members are preferably of sufficient resilience that the perforations of the sheet remain open to the second side of the article during normal use, i.e. so that the second side of the article is not normally pressed against the surface.

The spacer members may suitably comprise a network of ribs extending across substantially all of at least one side of the article or fabric, the ribs thereby providing walls beside each dome projection of the second major face of the sheet. If desired, the air space thereby defined over the dome projections can be covered by an air-permeable sheet cover member extending between the ribs and secured (e.g. sealed) thereto.

In a particularly preferred arrangement an air-permeable sheet cover member may be a water-absorbent cloth or other fabric, e.g. of hydrophilic fibres such as high-wicking microfibres, particularly polyesters. Such a cover member provides a high wicking action which absorbs moisture passing out

through the perforations of the sheet from the first to the second major face of the sheet. In this way, the surface against which the article is located can be maintained as dry as possible. Alternatively, the air-permeable sheet cover member may, for example, be a waterproof but vapour-permeable membrane. Still further, such a waterproof but vapour-permeable membrane may be used together with a water-absorbent fabric, e.g. externally of the water-absorbent fabric to confer waterproofness. If desired, such a composite may be a laminate with the different layers being bonded together in conventional manner.

The surface which in use overlies the article of the present invention and is spaced therefrom by the spacer members of the sheet may be rigid or flexible, perforated or unperforated, permeable or impermeable. The article of the present invention can also be wound around a part (e.g. a limb) of a person or animal's body, in which case the overlying around a part of a person or animal's body, the surface will be the first major face of that portion of the sheet which is wound over the portion of the sheet adjacent the person or animal's body, i.e. the article (e.g. a bandage) will be wound over itself.

The article of the present invention may, for example, take the form of the following cushioning and lining articles permanently or releasable affixed to any surface, or for wearing between a person or animal's skin and any surface:

(a) apparel of all types, such as watersports apparel, and portions of such apparel (e.g. the seat portions of trousers);

(b) the fabric portions of wheelchairs (e.g. the seat, back and armrest portions);

(c) seats of all types, such as automotive seating, office seating, domestic seating, boat seating, commercial travel seating (e.g. bus, train and aircraft seating);

(d) headwear of all types;

(e) boot and shoe insoles and linings, in which case the surface is the interior surface of the boot or shoe;

(f) helmet linings, in which case the surface is the interior surface of the helmet;

(g) linings for body protectors, in which case the surface is the interior surface of the body protector;

(h) linings for body armour, in which case the surface is the interior surface of the body armour;

(i) linings for sports shields such as shin-pads, in which case the surface is the interior surface of the sports shield;

(j) under-blankets for bedding, in which case the surface is the upper surface of a mattress or the like;

(k) upholstery covers, in which case the surface is the surface of the upholstery;

(l) linings for clothing, in which case the surface is the interior surface of the clothing;

(m) orthopaedic cast linings, in which case the surface is the interior surface of the orthopaedic cast;

(n) linings for orthopaedic supports or hard braces, in which case the surface is the interior surface of the orthopaedic support or hard brace; and

(o) portions of the above if not specifically mentioned, particularly portions that are subjected to compressive forces in use.

The article of the present invention may also take the form of medical or veterinary dressings, which may for example be held onto the body by an overlying member (optionally with or without a contact adhesive between the dressing and the skin of the person or animal) or by winding the dressing onto itself around a part of the body (e.g. a limb).

The basic principle underlying the preferred mode of action of the perforations of the sheet is set out in WO-A 91/12958. This basic principle is

retained when a corresponding sheet is provided with spacer members according to the present invention. In essence, evaporation of sweat from the skin surface of the person causes an increase in the vapour pressure (density) within the hollow chambers of the sheet. Movement of the person's body, for example by walking in the case of an insole as the article of the present invention, will cause compression of the sheet and consequent distortion of the chambers and the domes. This leads to active pumping of the vapour from the chambers, through the perforations and out to the second side of the article. Here it will tend to condense, because the temperature is lower away from the wearer's body.

When the spacer members are provided with an air permeable, hydrophilic fibre, absorbent sheet cover member, enclosing an air space over the dome projections of the second major face of the sheet, condensed sweat will be absorbed into the fibres of the absorbent cover member. Sweat may not pass back through the perforations after condensation. Even when the sweat is still vaporous in the air space over a dome projection, it will not return to the chambers of the first major face of the sheet due to the positive thermal and diffusion gradient from the first to the second major face of the sheet.

The perforations and associated chambers are suitably of sufficient size and spacing apart to permit the natural biological functions of the user's skin to continue substantially unhindered over a desired period of time, while permitting a controlled (but not excessive) retention of the user's body heat.

The components of the article or fabric should be non-toxic, non-irritant and comfortable to wear (in the sense of lightweight, flexible and soft to the touch), as well as being resistant to attack and degradation from all natural by-products of the user's body (e.g. sweat, blood, tissue fluid, urine, pus, and gases such as carbon dioxide).

It is preferred that the article will provide substantial protection to the wearer from cold or other external hazards (e.g. water, chemicals, bacteria, air

etc), while permitting an enhanced air-exchange efficiency as soon as high levels of wearer activity arise, which cause the perforations to open due to flexing of the article and/or the higher temperatures and pressures within the chambers of the sheet. In such articles, the perforations may conveniently be interspersed with smaller numbers of other types of perforation according to the present invention and/or other (e.g. conventional) perforations. In one particular form, the perforations open when the vapour pressure of moisture in the chamber(s) reaches saturated vapour pressure.

By selecting particular elastomeric materials, particular lamina thicknesses, particular sizes of chambers and perforations, different concentrations of perforations over the sheet area and/or different arrangements of perforation types over the area of the sheet, the article's properties can be adjusted to suit the intended use. Moreover, by careful selection of materials and configuration, the article can be made to respond in its "breathability" to variations in external conditions and/or in the user's biological functions, so that to some extent such articles can self-regulate their "breathability" and hence automatically control the environment next to the wearer's skin within a pre-set temperature range.

The fabric and articles made therefrom may be manufactured according to conventional methods. Thus, for example, a foamed or unfoamed elastomeric sheet can be press-formed, e.g. by thermoformation under pressure, or vacuum-formed, to provide the required chambers, domes and space members and the sheet can be perforated by pins to provide the perforations. The perforation of the sheet can be simultaneous with the press-forming or vacuum-forming or at a different time from the press-forming or vacuum-forming.

Alternatively, the spacer members can be laminated to the remainder of the sheet. This will be appropriate when the resilience of the spacer members must be different from that of the perforated portion of the article. In such a method, a first sheet portion of a first elastomeric material may be press-

formed or vacuum-formed to provide the required chambers and domes and the sheet can be perforated by pins to provide the perforations. As before, the perforations of the sheet can be simultaneous with the press-forming or vacuum-forming or at a different time from the press-forming or vacuum-forming. A second sheet portion of a second elastomeric material (typically different from the first elastomeric material) can have relatively large holes punched through it, which are large enough to comfortably receive the domes projecting from the first sheet portion. The two sheet portions can be laminated together in this configuration, whereby the second sheet portion provides the space members according to the present invention.

Where additional permeable layers are to be laminated or bonded to the fabric, e.g. across the spacer members to enclosed an air space above the domes to the second major face of the sheet, this lamination or bonding may be achieved in conventional manner, using known materials and methods.

The present invention goes at least some way to providing a simple, inexpensive, comfortable, insulating, washable and effective lining system for wearing between a person or animal and an outer covering, thereby addressing the problems described above in the introduction.

BRIEF DESCRIPTION OF THE DRAWINGS

For ease of understanding of the present invention, and to show how it may be carried into effect, embodiments will now be described, purely by way of example and without limitation, with reference to the accompanying drawings, in which:

Figure 1 shows a partially cut away perspective top view of a fabric from which a breathable article can be manufactured.

Figure 2 shows a schematic side view of part of the fabric of Figure 1; and

Figure 3 shows an enlarged schematic side view of part of a modified fabric incorporating a cover member to enclose an air space over the second major face of the sheet.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings, in which like parts are designated alike, there is shown a fabric sheet 1 from which a breathable article can be manufactured. The fabric sheet has first 2 and second 3 major faces defining first and second sides of the fabric. These first and second major faces of the fabric sheet 1 would be directed towards corresponding first and second sides of the finished article. In use, an article manufactured from the fabric would be near a person or animal's skin 4, the person/animal being to the first side 2 of the fabric and a surface 5 being to the second side 3 of the fabric so that the article is disposed between the person/animal and the surface.

The fabric sheet 1 consists of a sheet formed of foamed elastomeric neoprene having small pin-prick sized perforations 6 provided therethrough. Circular hollow chambers 7 are provided in the first major face 2 of the sheet, one in the region of each perforation 6, so that a perforation coincides with the apex of each chamber. The second major face 3 of the sheet is provided with dome projections 8, one in the region of each perforation 6, so that a perforation also coincides with the apex of each dome.

The arrangement permits air passing from the first to the second side of the fabric to accumulate in a chamber 7 under increased pressure prior to passing out through the perforation 6 to the second side of the fabric. During this process, the elastomeric sheet can flex, both under the effect of the pressure changes and as a result of mechanical bending. These flexing movements contribute to a positive pumping effect which causes an efficient transfer of moisture-laden air through the fabric from its first to its second side.

There are further provided a plurality of spacer members in the form of ribs 9 which project from the second major face 3 of the sheet between the perforations 6 and serve to space an article made from the fabric from the surface 5, whereby the flexing action can continue unhindered, even if the person's weight tends to squash the article 1 against the surface 5.

The elastomeric materials may, if desired, be covered by a thin layer of a skin-compatible material (not shown), which may suitably be a woven natural and/or synthetic cloth, comprising cotton, nylon or mixtures thereof. The ribs 9 are shown integral with the sheet, but may alternatively be laminated to the sheet as described generally above.

Referring particularly to Figure 3, the sheet 1 may further have a water-absorbent fabric layer 10 (e.g. a hydrophilic microfibre woven fabric) bonded to the ribs 9 so as to enclose an air space above the dome projections 8, each air space being bounded by a projection 8, the ribs 9 and the water-absorbent fabric layer 10. As described above, the water-absorbent fabric layer may, if desired, be replaced or supplemented by a waterproof but vapour-permeable membrane, for example to confer waterproofness.

The absorbent fabric layer 10 preferably exhibits a high wicking effect and absorbs any liquid water which contacts it. This retains moisture within the fabric, and restricts condensation on the surface 5. The fabric is easily replaced or washed periodically to eliminate the accumulated moisture. Provided that it is hygienic and acceptable to do so, the fabric could alternatively be dried overnight for reuse, without washing.

The illustrated fabric is suitably manufactured by conventional press-forming or vacuum-forming of a foamed neoprene sheet, to form the chambers 7, domes 8 and spacer members 9. If desired, the water-absorbent fabric layer 10 may be bonded to the spacer members 9 in conventional manner using conventional contact adhesives. The perforations 6 may suitably be formed by pins, optionally simultaneously with the press-forming step.

The illustrated fabric is found to maintain its breathability and the advantages of the active pumping effect of the domes 8 and chambers 7, even when it is being compressed by the weight of a person. This significant advantage has not hitherto been available, and has severely limited the application of advanced breathable fabrics to uses as linings within a relatively tightly fitting outer covering.

The foregoing broadly describes the present invention without limitation to the particular illustrated embodiments. Variations and modifications as will be readily apparent to those of ordinary skill in this art are intended to be included within the scope of this application and subsequent patent(s).